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Molecular characterization of phosphate-solubilizing rhizobia isolated from *V. faba* in Marrakech region field cultures

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Low soil phosphorus availability is among the major constraints for crops especially when they are depending on symbiotic nitrogen fixation. Rhizobial strains, beneficial N₂-fixing symbiotic partners of legumes, were reported to solubilize both organic and inorganic complex phosphates. The current study is carried out to select rhizobial strains isolated from nodules of faba bean cultures in Marrakech-Haouz region in Morocco and to investigate their ability to solubilize the complex mineral P. Our results revealed that among 80 isolates of rhizobia strains, 20 are able to solubilize the mineral P forming halo around their colonies on TCP agar. We evaluated and compared the effect of 8 strains on growth and phosphorus uptake by two Moroccan varieties of faba bean (*Vicia faba* L.) plants (Aguadulce and Defes). The Greenhouse experiments showed contrasting effect of strains on nodulation rate and plant growth depending on the inoculated strain and the symbiotic combination. The molecular characterization of rhizobial strains was performed by PCR amplification and sequencing of 16s rRNA coding gene, rec A and nod D genes and also the pqq C gene encoding the pyrroloquinoline quinone synthase C applied in the phosphate-solubilization by bacteria. The majority of the rhizobial strains belonged to *Rhizobium leguminosarum*. Some strains were identified as *Ensifer meliloti* (formerly *Sinorhizobium meliloti*). The gene pqq C was detected in 9 rhizobia strains.

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Phosphorus and nitrogen uptake of potato under water saving irrigation regimes

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Because of the worldwide shortage of fresh water, and depletion of non-renewable resources of phosphorus (P), concurrent maximization of nutrient use efficiency and saving water are demanded in crop systems. The objective of this study was to investigate whether potato production with high P and nitrogen (N) uptake can be obtained under the water saving irrigation regimes of: Partial Root-zone Drying (PRD) and Deficit Irrigation (DI). Potatoes were grown in split-root pots in a climate-controlled glasshouse. N and P were applied 153 and 37 kg/ha respectively. From four weeks after planting, the plants were treated with either full irrigation (FI), PRD or DI for two months. The result indicated that, compared with FI, both DI and PRD significantly improved water use efficiency (WUE) but decreased leaf area and biomass. Compared with FI, both PRD and DI saved 38% water and significantly improved tuber WUE with 35% but decreased tuber production with 15%. The total N and P uptake were same with DI and PRD and were significantly lower than FI. N uptake in shoot was significantly higher in PRD treatments than DI, while there was no difference in shoot P uptake. Physiological phosphorus use efficiency (PPUE) with FI and PRD were similar and both were significantly higher than DI. We conclude that, with limited freshwater resources, application of PRD irrigation could be a promising approach for saving water and when saving the same amount of water, PRD has advantages compared to DI in terms of improved shoot N uptake and PPUE. However, challenges remain as to maintaining P uptake under the decreased soil water regimes used in contemporary water saving irrigation strategies.

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Growth of Australian native pasture species (genus *Rytidosperma*) in response to application of phosphorus fertiliser

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Rytidosperma species (wallaby grass) are native perennial grasses found in temperate grasslands of southern Australia. They are considered to be well adapted to low phosphorus (P) soils and reports vary as to whether they can respond and/or persist when P fertiliser is applied to increase production. However, the responses of *Rytidosperma* species to management are often considered collectively because the species cannot be distinguished using vegetative traits. This makes grassland botanical composition difficult to assess. This study examined the growth of nine *Rytidosperma* species, *Lolium perenne* and *Bromus hordeaceus* (introduced species) to six levels of applied P (ranging from deficient to sufficient) in a glasshouse under microswath conditions. Maximum shoot yield between the highest (*R. duttonianum*) and lowest (*R. erianthum*) yielding *Rytidosperma* species varied almost 2-fold. Two *Rytidosperma* species, *R. richardsonii* and *R. duttonianum*, yielded as well as *L. perenne* at high and low P supply. However, a number of *Rytidosperma* species were slow-growing and relatively unresponsive to P. Species that had a high maximum yield tended to also grow well at low P, except for *B. hordeaceus*, which did not thrive at low P, despite having a high maximum yield when fertilised. The productive *Rytidosperma* species had lower leaf area ratios, lower specific leaf areas and higher leaf dry matter contents than the introduced species. The study demonstrated that growth responses and P-requirements of the *Rytidosperma* species differ markedly. It is essential to know which species are present when managing a *Rytidosperma* grassland and making P-fertiliser decisions.

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Increasing the diversity of leguminous plant improves soil functionalities and wheat growth in a P-deficient soil

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A study was conducted in glasshouse conditions to assess the influences of the leguminous plant diversity on the soil microbial functions and their consequences on the wheat growth. Three legume species were targeted: faba bean, alfalfa and pea. All the combinations of one, two or three species were performed in pots filled with a P deficient soil collected from a field located near Marrakech (Morocco). After 3 months culture, the plants were harvested and the shoot and root parts were dried, weighed and analyzed for their N and P contents. The soil catabolic functions were measured using the SIR (Substrate Induced Respiration) method. The mycorrhizal soil infectivity was assessed according to Kisa et al. (2007) and the arbuscular mycorrhizal (AM) diversity was estimated by PCR/Sequencing. Fluorescent Pseudomonads (FP), known to have PGPR capacities have been enumerated, identified (PCR/sequencing) and characterized for their inorganic phosphate solubilizing activities and for their effect on wheat growth. The results showed that an increase of legume diversity involved: (i) significant differences between the microbial functions within the treatments, (ii) changes in the abundance and diversity of the AM communities, (iii) an increase of the FP abundance, most of them solubilizing inorganic phosphate and promoting the wheat growth. These results suggest that the management of the legume plant cover diversity can optimize the positive impact of legume on the agrosystem productivity resulting from an increase in soil microbial functions, soil microbial diversity, AM symbiosis efficiency in sustainable agricultural practices (crop rotation, intercropping systems, etc).

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